Research Article

L1–L2 interactions of vowel systems in young bilingual Mandarin-English children

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ABSTRACT

This study examined the influence of L1 (Mandarin)–L2 (English) interactions on the organization of vowel systems and fine-grained spectral features of vowel productions in young bilingual Mandarin-English children. The participants included 39 children (15 bilinguals, 15 Mandarin monolinguals, and 9 English monolinguals) at 5–6 years of age. The bilingual children were divided into Bi-low (at the early stage of English learning with low proficiency in English) and Bi-high (highly proficient in English) groups. Each participant was recorded producing one set of Mandarin words containing /a, i, u, y, ɤ/ and/or one set of English words containing /i, ɪ, e, æ, u,ʊ, o, ɑ, ʌ/. Formant frequencies at five temporal locations were measured. Both static (midpoint formant values) and dynamic (formant movement pattern, trajectory length) acoustic properties were examined. Bi-low children showed a strong effect of L1 on L2. The L1 features were maintained and transferred to the new phonetic system. Bi-high children produced L2 vowels in a near-native manner. Meanwhile, they tended to transfer some L2 features to their L1 and moved the L1 vowels closer to L2 vowels, which suggested an assimilatory process. Both static and dynamic spectral features were affected by L1–L2 interactions.

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1. Introduction

Based on the common belief of “earlier is better,” a large body of research has revealed that early L2 speakers, who started to acquire an L2 at a younger age, can produce and differentiate L2 sounds better than late L2 speakers, who started to acquire an L2 in adulthood (e.g. Aoyama, Guion, Flege, Yamada, & Akahane-Yamada, 2008; Baker, Trofimovich, Flege, Mack, & Halter, 2008; MacLeod, Stoel-Gammon, & Wassink, 2009; Meador, Flege, & MacKay, 2000). Some researchers reported that bilinguals who started to acquire an L2 before puberty showed little or no difference in the production of the L2 sounds or the discrimination of L2 contrasts from the native speakers (Flege, MacKay, & Meador, 1999; Mack, 1989; MacLeod & Stoel-Gammon, 2005). In addition to the monolingual-like ability of L2, some researchers found that early bilingual speakers were able to retain monolingual-like ability in their L1 (MacLeod et al., 2009). For those studies that found no difference between early bilinguals and monolinguals of each language, the underlying assumption was that the early bilinguals could develop two separate phonetic systems independently.

However, many previous studies have suggested the interdependence of the two sub-systems in bilingual speakers (Grosjean, 1989; Keshavarz & Ingram, 2002; Paradis, 2001; Paradis & Genesee, 1996). Over the past few decades, the dynamic and continuing interaction between L1 and L2 has been intensively examined in adult speakers who started to learn an L2 at various ages (Baker & Trofimovich, 2005; Flege, Schirru, & MacKay, 2003; Kartushina, Hervais-Adelman, Frauenfelder, & Golestani, 2016). However, to what extent and in which manner the L1–L2 interactions affect the formation of phonetic systems in young bilingual children is not fully understood. So far, researchers have reported the development and organization of phonetic systems in English-learning children from diverse language backgrounds (e.g. Korean-English, Japanese-English, French-English, Arabic-English bilingual children) (Khattab, 2000; Lee & Iverson, 2012; Netelenbos & Li, 2013; Oh et al. 2011; Turner, Netelenbos, Rosen, & Li, 2015). Little research has been done to examine vowel production in young Mandarin-English children.
bilinguals. The present study aims to expand previous studies by investigating the organization of vowel systems and the change of static and dynamic spectral features of vowel productions under the influence of L1–L2 interactions in young bilingual Mandarin-English children.

1.1. Mutual influence between L1 and L2 phonetic systems

According to the Speech Learning Model (SLM, Flege, 1995), a bilingual’s L1 and L2 systems coexist in a common phonological space. Following this assumption, L1 and L2 would naturally influence each other. In particular, L1 and L2 sounds interact with each other at the allophonic level rather than the phonemic level. When the interactions between L1 and L2 are strong enough, the phonetic structures and the perceptual organization of both L1 and L2 in the bilinguals may change and show different patterns from those of monolinguals of each language. A large number of studies have evidenced that simultaneous bilinguals and early sequential bilinguals may still differ from monolinguals in their production and perceptual abilities (Heijen & Flege, 2006; Pallier, Bosch, & Sebastian-Gallés, 1997; Sebastian-Gallés & Soto-Faraco, 1999; Tsukada et al., 2005).

There are two types of interaction effects: an effect of L1 on L2 and vice versa. As Watson (1991) pointed out, for sequential bilinguals who learn an L2 after a complete or relatively complete acquisition of L1, their native language (L1) is used as the base on which to establish the L2 phonetic system. In this case, bilinguals are likely to assimilate the phonetically similar L2 sounds into established L1 categories at the beginning of L2 acquisition. However, not every L2 sound is equally assimilated to an L1 sound category. The extent to which the L2 sound is assimilated to the L1 sound category is primarily determined by the phonetic-acoustic similarity between the L2 and L1 sounds (Perceptual Assimilation Model-PAM, Best, 1994, 1995; SLM, Flege, 1995). Following continuous exposure and immersion in L2, the influence of L1 on L2 is attenuated, and separate L2 sound categories may eventually be established.

Unlike the convergent findings regarding the effect of L1 on L2 in early stage L2 speakers, researchers hold divergent opinions on the influence of L2 on L1. Bohn and Flege (1992), for example, observed no change of L1 sounds as a function of L2 experience. By contrast, many other studies have reported a change in L1 as a result of L2 learning in both perception (Caramazza, Yeni-Komshian, Zurif, & Carbone, 1973; Hazan & Boulakia, 1993) and production (Flege, 1987; Flege & Hillenbrand, 1984; Harada, 2003; Kang & Guion, 2006; Mack, 1990). Among these studies, two opposite processes have been observed: dissimilatory processes and assimilatory processes. A dissimilatory process takes place when a new phonetic category in L2 has been established and speakers shift a phonetically similar L1 sound away from the L2 sound to make a contrast between the two sounds (Guion, 2003; Mack, 1990; Oh et al., 2011; Yusa et al., 2010). Guion (2003) found that Quichua (L1) vowels systematically raised and moved away from the similar L2 (Spanish) vowels in Quichua-Spanish bilinguals who had developed distinct vowel categories for the L2. However, researchers have also found instances of a shift in an L1 sound towards an acoustically similar L2 sound, which represents an assimilatory process (Chang, 2012; Flege, 1987). Flege (1987) found the forward movement of French (L1) /u/ as a result of influence from English (L2)/u/ that was located in a more fronted position relative to French /u/. Chang (2012) found that only six weeks’ intensive immersion in Korean (L2) resulted in noticeable assimilatory modification of most English (L1) sounds in native English speakers. Kartushina et al. (2016) also reported a drift of native vowels (French vowel /ø/ and /y/) to non-native vowels (Russian /ɨ/) after short-term visual articulatory feedback training in native French speakers.

Efforts have been made to uncover the underlying driving forces of dissimilatory and assimilatory processes of L1 sounds as a function of L2 immersion (Chang, 2012, 2013). Although no consensus has been reached regarding this, researchers have shown that the magnitude and direction of L1–L2 interaction in bilinguals are highly correlated with the starting age of L2 learning and the amount of L2 experience. Baker and Trofimovich (2005) examined vowel production in Korean-English bilinguals differing in age of exposure to L2 (early and late) and the amount of experience with L2 (+1 and +7 years) in comparison to monolingual speakers. They found that late bilinguals’ L1 (Korean) vowels showed no differences from monolingual Korean speakers while their L2 (English) vowels were quite different from those produced by monolingual English speakers as a result of the influence of their L1. However, for the early bilinguals, the inexperienced speakers (+1 year experience with L2) maintained their L1 (Korean) vowels, but they were less likely to separate the L2 (English) vowels. The experienced speakers (+7 years’ experience with L2) better separated the vowel categories in the L2, but they differed from monolingual speakers of each language in certain vowels. These findings demonstrated that early bilinguals, especially experienced early bilinguals, showed different features from monolinguals of each language as a result of bidirectional influence between their L1 and L2. By contrast, late bilinguals showed a unidirectional influence of their L1 on the L2.

In addition to the bi-directional interaction, researchers also reported distinct patterns of phonetic drift for L2 sounds in early bilinguals and late bilinguals. For example, Flege et al. (2003) compared the production of English /ei/ and Italian /eː/ by Italian (L1)–English (L2) bilinguals varying in the age of learning (early and late) and the amount of English usage (low and high). The English /eː/ produced by native English speakers is characterized by a greater formant movement relative to a typical Italian /eː/. The authors found that whereas the early-low bilinguals tended to dissipilate the L2 sound from the L1 counterpart by overshooting the English /eː/ with greater formant movement, the late bilinguals always assimilated the L2 sound to similar L1 sound by undershooting English /eː/ with less formant movement. These findings were, to a large extent, based on adult and adolescent L2 speakers. Previous studies have shown continuing refinement of acoustic properties in children’s vowel production (Yang & Fox, 2013) and the privilege of neural plasticity in young children as opposed to adults in language learning (e.g. Stiles, 2000). In the present study, we were interested in how the L1–L2 interactions would be manifested in young bilingual children.
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